Title
Rodent Research and Education

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Cooperators
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Abstract
Rodent pests affect people in a variety of ways, from causing structural damage and contaminating food, to spreading disease. To reduce human-rodent interactions requires knowledge of rodent behavior and biology. The NYS IPM Program collaborates with researchers, pest management professionals, manufacturers of pest management products, and the public to generate and disseminate information that is intended to increase adoption and implementation of integrated pest management for rodents. In 2017, members of the Community IPM Program attempted to launch a research project designed to understand and improve rodent management practices at food distribution centers. Despite considerable effort, this project has faced several challenges in terms of site access and availability of pest management products. The IPM Program provided feedback on two manuscripts published in primary journals about rodent-borne disease, reached over 2,100 individuals in face-to-face and virtual presentations, prepared articles that were distributed by state and regional organizations, and developed new resources to help identify opportunities for exclusion, to implement an effective rodent monitoring program, and to facilitate communication between pest professionals and their clients

Background and Justification
Commensal rodents are a pest species that affect New Yorkers in urban, suburban and rural areas. Their ability to gnaw on objects to gain access to an area or obtain perceived resources can cause physical damage to buildings not just by chewing through doors and walls, but potentially causing fires when wires are exposed. Through consumption and defecation, rodents contaminate food and are important reservoirs of human disease. Long-term exposure to rodent hair, droppings and urine can result in both asthma and allergies, especially for children (Jeal and Jones 2010) living in urban environments where abundant food, water and shelter support large rodent populations. Exposure to rodents also poses a risk of zoonotic disease transmission for a range of bacterial, parasitic, protozoan, and viral pathogens (Meerburg et al. 2009). These can be transmitted directly through bites or indirectly by exposure to urine, feces or ectoparasites.

Despite their pest status, rodent management remains a challenge. This is due in part to the complex biology and behavior of rodents, and a lack of understanding of best management techniques to address populations – not just individuals. In addition, human

behaviors often contribute to rodent populations, with poor sanitation and exclusion providing access to resources that rodents need to survive (food, water and shelter). As a result, human-rodent interactions continue, with some having dire consequences for human health (https://www1.nyc.gov/site/doh/about/press/pr2017/pr004-17.page).

To improve rodent management practices and reduce risks associated with these pests, research to better understand population dynamics and current management practices is needed. This information must then be disseminated in a meaningful way to individuals and organizations that implement rodent management.

Objectives

1. Evaluate the effectiveness of rodent management practices at food distribution centers.
2. Contribute to research publications examining rodent-borne disease dynamics in New York.
3. Develop and deliver educational resources and presentations that will lead to increased adoption of IPM practices.

Activities

Rodent Research at Food Distribution Centers.

The goal of this Hatch-funded project is to evaluate and improve rodent management practices at food distribution centers in New York. Currently, most pest management companies that service food distribution centers install rodent management equipment according to guidelines set forth by third party auditors. For example, mousetraps are installed on either side of every door and at 25-foot intervals along the interior walls of the building, while rat bait stations are installed every 50 to 100 feet on the exterior perimeter of the facility. The theory behind these placements is that they provide a barrier against rodents, intercepting them before they cause damage on the interior of the facility. However, these guidelines are not based on an understanding of rodent biology and may contribute to the use of excess traps and pesticide bait that are not likely to intercept rodents. Furthermore, these devices are checked by a pest professional, which can increase service time unnecessarily. Therefore, this project aims to improve the efficiency and efficacy of rodent management programs at food distribution centers by placing devices where they are likely to intercept rodents: near sources of food, water, shelter and heat. These areas are identified by inspections, and trap catches/bait removal will compared to traps placed according to interval placements. This research will take place at 4 distribution centers in the metropolitan NY area.

Contribute to Research Publications.

In 2017, two research groups utilized data collected in 2012-3 by Columbia University and NYS IPM on rodents in NYC (see Firth et al. 2014 and Frye et al. 2015). Manuscripts prepared by these groups were reviewed and comments were provided, including responses to reviewers. A blog post was prepared about this recent rodent research.

Develop and Deliver Educational Resources and Presentations.

A number of presentations were offered to pest professionals about rodent management and exclusion at professional meetings, while new resources were created to improve IPM

adoptions and implementation. The IPM Program continues to answer questions and assist the public with rodent management.

Results and Discussion

Rodent Research at Food Distribution Centers.

The greatest challenge facing this research project is site access. Beginning in November 2016, pest professionals in the metropolitan NY area, as well as regional representatives of national firms, were contacted to assist with finding food distribution centers that have active rodent populations. Local representatives of national companies that distribute pest management products sent a request for collaboration to pest professionals on our behalf, and an article was written for Pest Control Technology Magazine, Quality Assurance and Food Safety Magazine, and Food Safety Magazine that described the project and solicited cooperation (the article was also picked up by PestWeb by Univar, a distributor of pest management products). In addition, a list of food distribution centers was obtained from New York State Agriculture and Markets, and more than 30 cold call visits were made to sites throughout the Hudson Valley.

A few pest professionals have expressed interest in partnering on this project, mostly because of the opportunity to work with Dr. Bobby Corrigan and to learn new techniques. However, in most cases the sites have not been appropriate due to a lack of rodent pressure. The trend is that sites without rodent problems are willing to participate because they have nothing to hide, while sites with known problems are unwilling to participate because they have something to hide. Interestingly, a colleague has expressed this and other similar challenges in rodent research in an article published in the Journal of Urban Ecology (Parsons et al. 2016).

By April 2017, two sites had been identified for the study, but obtaining supplies posed a new complication. The process to order materials was initiated with one national distributor in May 2017, but for reasons beyond our control the order was never filled. A second national distributor was contacted in October 2017, but due to complications and delays in the process of ordering materials, the sites with rodent problems had promptly addressed them, making them no longer suitable for study.

A new collaborator has since stepped forward and has offered his sites for study. While these sites seem to have limited rodent problems, detailed record keeping by the company could offer another way of gathering data. Specifically, this company uses electronic monitoring to document trap catches on a facility map. By performing detailed inspections at sites with rodent activity and documenting sources of heat, water, food and entry on the maps, it might be possible to use historic data to determine if rodent activity is concentrated in these areas. This would not be a manipulative study with an intervention, but could provide insight into this question. Our plan at this point is to request a no-cost one year extension on this project to achieve program goals in 2018 and 2019.

Contribute to Research Publications.

*Peterson, AC, BM Ghersi, F Alda, C Firth, **MJ Frye**, Y Bai, LM Osikowicz, C Riegel, WI Lipkin, MY Kosoy, & MJ Blum. 2017. Rodent-borne Bartonella infection varies according to host species within and among cities. EcoHealth 14(4): 771-782. https://doi.org/10.1007/s10393-017-1291-4*

This study led by researchers at Tulane University examined rodent infection with *Bartonella* in New Orleans and New York. The results of the study demonstrate that rats in both cities are host to multiple species of this bacterial pathogen, and that the occurrence of *Bartonella* depended on the exact site rats were collected. In New Orleans, the species of rat that served as a reservoir host also influenced the presence and prevalence of disease.

Angley, LP, MC Combs, C Firth, ***MJ Frye****, I Lipkin, JL Richardson, & J Munshi-South. 2017. Spatial variation in the parasite communities and genomic structure of urban rat vectors in New York City. Zoonoses and Public Health 65: e113-e123.*
Similar to the work by Peterson et al., this paper documented an uneven distribution of rodent pathogens in New York. Whereas some rat populations had very high infection rates and a greater diversity of pathogens and ectoparasites, infection rates were lower in nearby populations. Interestingly, rats from similar environments (housing versus parks or multiuse areas) had similar genomics, while nearby rats in different microenvironments showed greater differences.

Following publication of these and other articles in November 2017, a post about recent rodent research was published on the *Think*IPM blog: "Rats! The latest research comes with surprises." A more technical version of this article entitled "Recent Rodent Research" was reprinted by the New England Pest Management Association, New York Pest Management Association and New Jersey Pest Management Association in their newsletters.

Develop and Deliver Educational Resources and Presentations.
In 2017, a total of 11 presentations were offered in six states, plus two national webinars (Table 1). These presentations reached 2,112 participants at the time they were offered (viewing statistics for webinars after the air date are not available), for a total of 2,135 contact hours.

Table 1. 2017 presentations related to rodent management.

Conference/Meeting Name	**Sponsoring Organization**	**Location***	**Presentation Title**	**# people**	**Length (hrs)**	**Contact Hours**	**Date**
81st Annual Purdue University Pest Management Conference	Purdue University	West Lafayette, IN	Rodents: an Update on their Importance and Management	300	1	300	1/10/17
National Pest Management Association's Eastern Conference	National Pest Management Association	Atlantic City, NJ	Understanding the Disease Potential of Urban Rodents	325	1	325	1/18/17
National Pest Management Association's Eastern Conference	National Pest Management Association	Atlantic City, NJ	Controlling Mice in Residential Settings	200	1	200	1/19/17
National Pest Management Association's Eastern Conference	National Pest Management Association	Atlantic City, NJ	Pest Exclusion – An Old Concept with a New Life	350	1	350	1/20/17
57th Annual Short	Delaware	Newark,	Rodentology	180	1	180	2/15/17

Course	Pest Control Association	DE	and Pest Management				
Annual Pest Invasion Seminar	McCloud Services	Oakbrook, IL	Exclusion: The Future of Pest Management	350	1	350	4/25/17
NYS IPM Staff Meeting	NYS IPM	Geneva, NY	Rodent Realities: IPM at Food Distribution Centers	22	0.2	4.4	5/18/17
PestWorld 2017	National PM Assoc.	Baltimore, MD	Exclusion: The Future of Pest Management	129	1.25	161.25	10/27/17
PestWorld 2017	National Pest Management Association	Baltimore, MD	Developing a Pest Exclusion Program for Cockroaches and Rodents	129	1.25	161.25	10/27/17
Lunch 'N' Learn Webinar	Food Protection Alliance	Webinar	Rodent Exclusion: the Time is Now!	46	0.5	23	11/14/17
Virtual Rodent Control Summit	Pest Control Technology	webinar	Developing a Comprehensive Rodent IPM Program	81	1	81	11/29/17

Slides from a presentation delivered to the Pennsylvania Vector Control Association (21 Oct 2016, "Harboring Secrets: Pathogens & Ectoparasites of Norway Rats in NYC") are being used for rodent education programs administered by the Allegheny County Health Department in Pennsylvania.

At the request of a colleague, an article was prepared that discusses common misunderstandings about rodenticide tracking powders, and highlight the risks of these products as described on the label. "Tracking Powders in Rodent Management: A Cautionary Tale" was posted to the Community IPM publications page, and was reprinted in the June 2017 newsletters of the New York Pest Management Association and the New Jersey Pest Management Association.

An inspection was completed at a condominium complex in Westchester County, NY that was dealing with an ongoing rodent infestation. During the inspection, areas were identified that must be accessed when dealing with a rodent infestation in multiunit buildings, and these areas contained considerable rodent droppings. The rodent activity is confined to one half of the building (eight units), likely due to the presence of a firewall that prevents access to the other side. A report was submitted to the property manager with recommendations to address the current infestation (reduce the population) and tips prevent the spread of subsequent introductions through exclusion.

Pest exclusion is a growing part of the rodent management message, and members of the NYS IPM Program have played a key role in the Scientific Coalition on Pest Exclusion. In

2017, new forms were developed to help pest management professionals, building inspectors and others to identify opportunities for exclusion, to implement an effective rodent monitoring program, and to facilitate communication between pest professionals and their clients (Appendix A, Figures 1-4). Inspections using these and other forms have been completed on Long Island and in Geneva, NY.

A session on exclusion, "Partnerships to Strengthen the Role of Pest Exclusion in IPM" was planned, submitted and accepted in 2017, and will take place at the 9th International IPM Symposium in Baltimore on Thursday, March 22nd. The IPM Program was present for a meeting of the recently formed "Pest Stoppage Team," a collaboration of the NYC Dept. of Health and Mental Hygiene Bureau of Veterinary and Pest Control Services, New York City Housing Authority and Healthy Homes Program. This meeting involved a presentation from Dave Colbert of GMT, Inc., the company that manufactures Xcluder rodent exclusion products. In addition to this presentation, the group visited a housing site and observed the needs for pest exclusion.

This report highlights the various efforts undertaken in 2017 to better understand commensal rodents and to educate the pest management industry and others on Integrated Pest Management techniques for rodents.

References

Firth, C, M Bhat, MA Firth, SH Williams, MJ Frye, P Simmonds, JM Conte, J Ng, J Garcia, NP Bhuva, B Lee, X Che, P-L Quan, WI Lipkin. 2014. Detection and characterization of human pathogens in commensal *Rattus norvegicus* in New York City. mBio 5(5) e01933-14.

Frye, MJ, C Firth, M Bhat, MA Firth, X Che, D Lee, SH Williams & WI Lipkin. 2015. Preliminary survey of ectoparasites and associated pathogens from Norway rats in New York City. J. Med. Ent. 52(2): 253-259.

Jeal, H. and M. Jones. 2010. Allergy to rodents: an update. Clin. Exp. Allergy 40: 1593-1601.

Meerburg, BG, GR Singleton, and A Kijlstra. 2009. Rodent-borne diseases and their risks for public health. CRC Cr. Rev. Microbiol. 35: 221-270.

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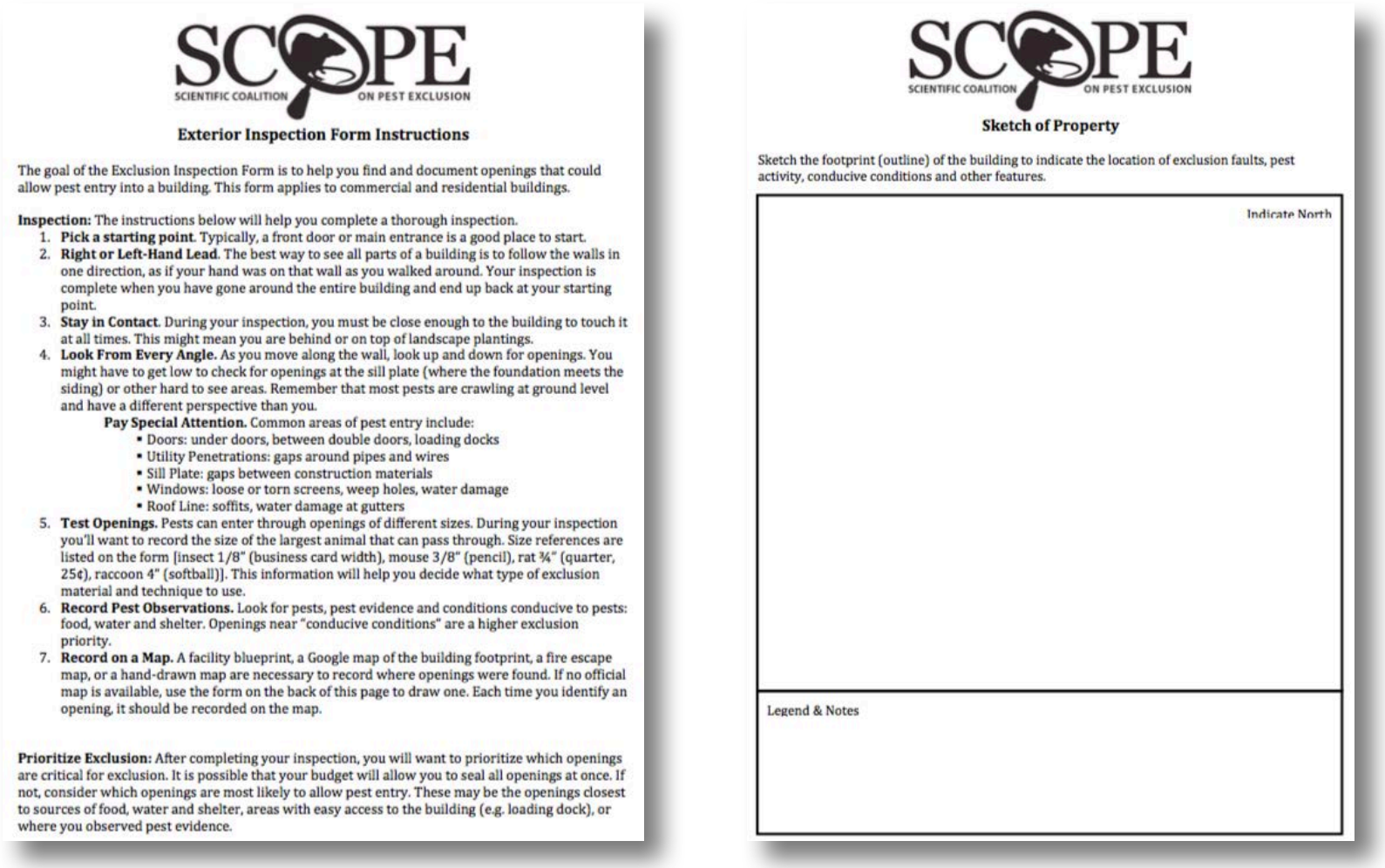
Appendix A



SCIENTIFIC COALITION ON PEST EXCLUSION

Exterior Inspection Form Instructions

The goal of the Exclusion Inspection Form is to help you find and document openings that could allow pest entry into a building. This form applies to commercial and residential buildings.

Inspection: The instructions below will help you complete a thorough inspection.

1. **Pick a starting point**. Typically, a front door or main entrance is a good place to start.
2. **Right or Left-Hand Lead**. The best way to see all parts of a building is to follow the walls in one direction, as if your hand was on that wall as you walked around. Your inspection is complete when you have gone around the entire building and end up back at your starting point.
3. **Stay in Contact**. During your inspection, you must be close enough to the building to touch it at all times. This might mean you are behind or on top of landscape plantings.
4. **Look From Every Angle.** As you move along the wall, look up and down for openings. You might have to get low to check for openings at the sill plate (where the foundation meets the siding) or other hard to see areas. Remember that most pests are crawling at ground level and have a different perspective than you.

   Pay Special Attention. Common areas of pest entry include:
   - Doors: under doors, between double doors, loading docks
   - Utility Penetrations: gaps around pipes and wires
   - Sill Plate: gaps between construction materials
   - Windows: loose or torn screens, weep holes, water damage
   - Roof Line: soffits, water damage at gutters
5. **Test Openings.** Pests can enter through openings of different sizes. During your inspection you'll want to record the size of the largest animal that can pass through. Size references are listed on the form [insect 1/8" (business card width), mouse 3/8" (pencil), rat ¾" (quarter, 25¢), raccoon 4" (softball)]. This information will help you decide what type of exclusion material and technique to use.
6. **Record Pest Observations.** Look for pests, pest evidence and conditions conducive to pests: food, water and shelter. Openings near "conducive conditions" are a higher exclusion priority.
7. **Record on a Map.** A facility blueprint, a Google map of the building footprint, a fire escape map, or a hand-drawn map are necessary to record where openings were found. If no official map is available, use the form on the back of this page to draw one. Each time you identify an opening, it should be recorded on the map.

Prioritize Exclusion: After completing your inspection, you will want to prioritize which openings are critical for exclusion. It is possible that your budget will allow you to seal all openings at once. If not, consider which openings are most likely to allow pest entry. These may be the openings closest to sources of food, water and shelter, areas with easy access to the building (e.g. loading dock), or where you observed pest evidence.

SCIENTIFIC COALITION ON PEST EXCLUSION

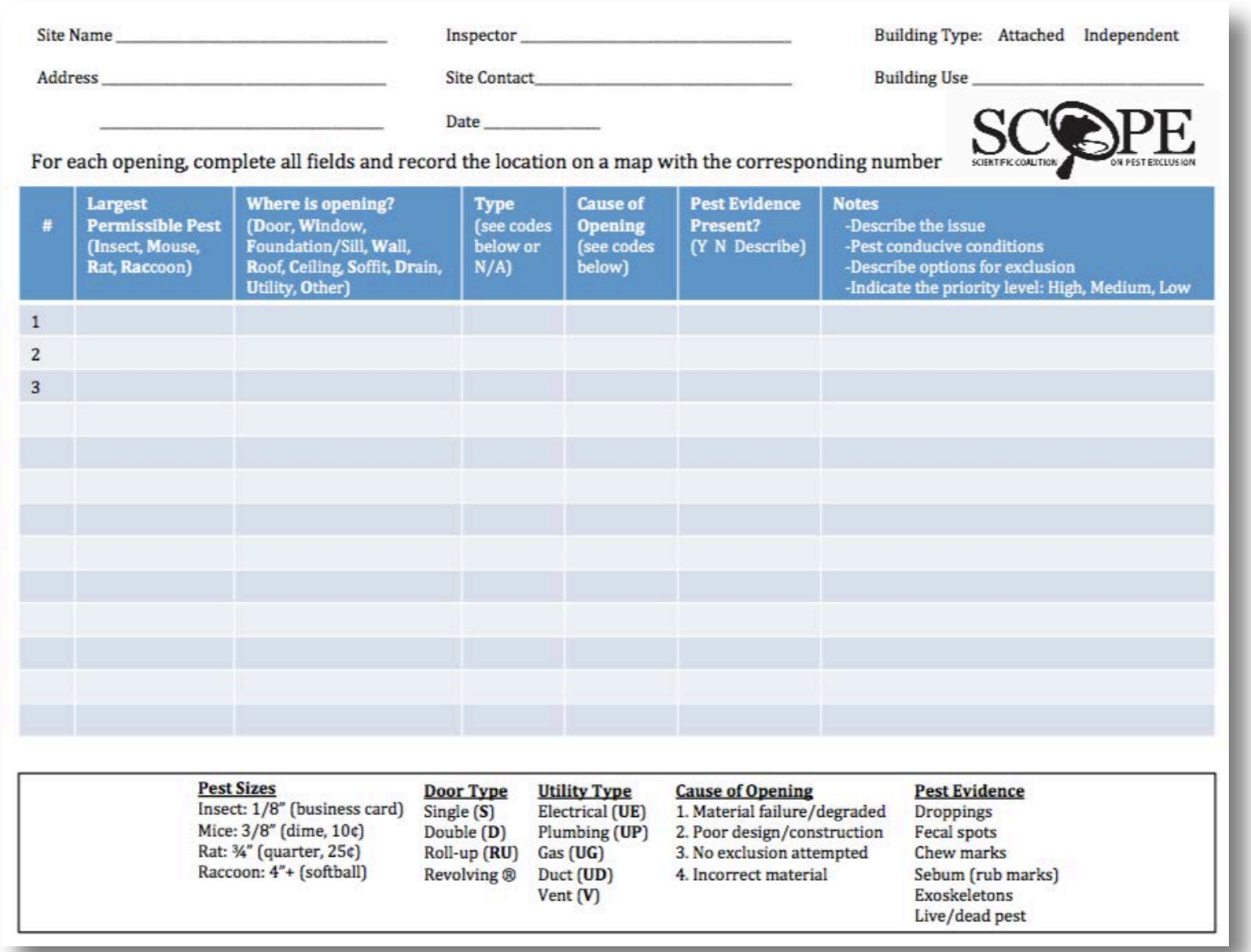
Sketch of Property

Sketch the footprint (outline) of the building to indicate the location of exclusion faults, pest activity, conducive conditions and other features.

Indicate North

Legend & Notes

Figure A1. Exterior Inspection Form provides instruction on how to perform a thorough building inspection to identify pest (rodent) entry points. Although not complete at this time, a second document (Performing Exclusion) is a corollary to this document, offering practical tips for implementing exclusion.



Site Name _____ Inspector _____ Building Type: Attached Independent

Address _____ Site Contact _____ Building Use _____

_____ Date _____

SCOPE SCIENTIFIC COALITION ON PEST EXCLUSION

For each opening, complete all fields and record the location on a map with the corresponding number

#	Largest Permissible Pest (Insect, Mouse, Rat, Raccoon)	Where is opening? (Door, Window, Foundation/Sill, Wall, Roof, Ceiling, Soffit, Drain, Utility, Other)	Type (see codes below or N/A)	Cause of Opening (see codes below)	Pest Evidence Present? (Y N Describe)	Notes -Describe the issue -Pest conducive conditions -Describe options for exclusion -Indicate the priority level: High, Medium, Low
1						
2						
3						

Pest Sizes
Insect: 1/8" (business card)
Mice: 3/8" (dime, 10¢)
Rat: ¾" (quarter, 25¢)
Raccoon: 4"+ (softball)

Door Type
Single (**S**)
Double (**D**)
Roll-up (**RU**)
Revolving (**R**)

Utility Type
Electrical (**UE**)
Plumbing (**UP**)
Gas (**UG**)
Duct (**UD**)
Vent (**V**)

Cause of Opening
1. Material failure/degraded
2. Poor design/construction
3. No exclusion attempted
4. Incorrect material

Pest Evidence
Droppings
Fecal spots
Chew marks
Sebum (rub marks)
Exoskeletons
Live/dead pest

Figure A2. This Exterior Inspection Form is used according to instructions in the previous document (Figure A1). The goal of this form is to help people identify gaps present in the structure they are inspecting, and to provide some information on why the opening is present.

Site Name _____ Address _____ Inspector _____

Site Contact_____ _____

New York State Integrated Pest Management Program

Rodent Monitoring Log

Date	Device #	Device Type [optional]	# Rodents	Rodent Species	Rodent Age	Rodent Sex	# Droppings	**Observations:** directionality, rodenticide exposure (droppings color), baited or runway trap, entry point, food source, water source, harborage, etc.

Device Type
MCT: Multiple Catch Trap
GT: Glue Trap
WST: Wooden Snap Trap
PST: Plastic Snap Trap
PCST: Plastic Clam Style Trap

Rodent Species
HM: House Mouse
WFM: White-Footed Mouse
NR: Norway Rat
RR: Roof Rat

Rodent Age
J: Juvenile
SA: Sub-Adult
A: Adult

Rodent Sex
M: Male
F: Female

HM: permanent residents. Find room/floor connections & voids
WFM: seasonal intruder. Consider exterior entry points
Juveniles travel together and often not far from the nest
-if catching juveniles, note that reproductive female present
HM A F: reproductive at 1+ month, reproduce monthly
RR/NR A F: reproductive at 2.5+ months, several litters per year

Figure A3. A specific monitoring log for rodents can be used to track pest pressure over time and to help identify the source of introductions or the location of nest sites. This form collects additional information that can help interpret pest evidence, such as the rodent species present, age and sex.

Site Name _____ Address _____ Inspector _____

Site Contact_____ _____ Date _____

NYS IPM New York State Integrated Pest Management Program

Category -Pest Mgmt -Sanitation -Exclusion	Priority 1. High 2. Medium 3. Low	Observation -Describe the issue and how it contributes to pest populations	Location [provide details for staff to find the issue]	Recommendations -Provide a solution to the problem you observed. What should the client do?	Image Number

Figure A4. One challenge faced by the pest management industry is the lack of cooperation by clients. Poor sanitation practices or an unwillingness to participate in exclusion (pay for or perform it) can lead to program failure. The goal of this form is to help prioritize effort for clients to facilitate cooperation.